

What is Claimed:

1. A transcranial magnetic stimulation (TMS) system for providing TMS treatment to a patient, comprising:
 - a TMS coil;
 - a pulse generating device that applies pulses to said TMS coil during TMS treatment of a patient;
 - a sensor disposed between said TMS coil and a position at which pulses are applied, said sensor detecting proximity of said TMS coil to said position; and
 - signal processing circuitry that processes outputs of said sensor to provide an indication of whether said TMS coil is properly disposed with respect to said position during application of pulses to said TMS coil.
2. A TMS system as in claim 1, wherein said TMS coil comprises at least one treatment face and said signal processing circuitry determines from said outputs of said sensor whether said at least one treatment face is disposed at said position.
3. A TMS system as in claim 2, wherein said TMS coil comprises first and second treatment faces corresponding to respective pole faces of said TMS coil and said signal processing circuitry determines from said outputs of said sensor whether said first and second treatment faces are disposed at said position.
4. A TMS system as in claim 1, wherein said signal processing circuitry processes said outputs of said sensor to determine if said TMS coil has a valid contact with a patient at said position.
5. A TMS system as in claim 1, wherein said indication is provided to a display device that indicates to an operator of said TMS system whether said TMS coil is properly positioned at the position.
6. A TMS system as in claim 5, wherein said display device further provides an indication of which direction to move said TMS coil to said position in the event that said TMS coil is not at said position.
7. A TMS system as in claim 5, wherein said display device presents a pressure map indicating where said TMS coil has proper contact at the position and where the TMS coil does not have proper contact at the position.

8. A TMS system as in claim 1, wherein said indication is provided to a sound generator that generates a sound that indicates to an operator of said TMS system whether said TMS coil is properly positioned at the position.

9. A TMS system as in claim 1, wherein said sensor comprises at least one sensor disposed in or on a flexible substrate that is, in turn, placed between said TMS coil and the position to determine if said TMS coil is properly positioned with respect to said position during TMS therapy.

10. A TMS system as in claim 9, wherein said at least one sensor comprises membrane switches that change state when depressed, each membrane switch comprising respective conductive films separated by a dielectric layer.

11. A TMS system as in claim 10, wherein said conductive films have a sufficient resistance so as to reduce eddy currents therein.

12. A TMS system as in claim 10, wherein said signal processing circuitry comprises a debounce circuit and an artifact detection and removal circuit.

13. A TMS system as in claim 10, further comprising non-conductive micro slides applied to said flexible substrate so as to amplify compression of said membrane switches.

14. A TMS system as in claim 10, wherein said membrane switches comprise resistive strips that provide an output voltage that varies with position of contact on said membrane switches.

15. A TMS system as in claim 14, wherein said membrane switches comprise an array of separators between said conductive films so as to form a touch screen.

16. A TMS system as in claim 9, wherein said at least one sensor comprises variable resistance sensors that provide an output signal that is proportionate to applied contact pressure, whereby a change in resistance above a predetermined threshold is identified as an indication of contact.

17. A TMS system as in claim 16, wherein said variable resistance sensors have high impedances so as to minimize induced current therein.

18. A TMS system as in claim 9, wherein said at least one sensor comprises at least one fluid displacement sensor and fluid filled bladders connected by a non-compressible

manifold to said at least one fluid displacement sensor such that compression of a bladder causes a change in pressure at the at least one fluid displacement sensor.

19. A TMS system as in claim 18, wherein said at least one fluid displacement sensor, said fluid filled bladders and said non-compressible manifold are disposed on an electrical shielding device disposed between the position and said TMS coil.

20. A TMS system as in claim 18, wherein fluid filled bladders are disposed directly over respective pole faces of said TMS coil.

21. A TMS system as in claim 20, wherein said signal processing circuitry comprises artifact removal circuitry and a threshold detection device that indicates whether a predetermined force has been applied to at least one of said fluid filled bladders by a corresponding pole face of said TMS coil so as to indicate proper contact of said TMS coil to the position.

22. A TMS system as in claim 18, wherein fluid in said fluid filled bladders comprises a substantially non-electrically-conductive fluid.

23. A TMS system as in claim 9, wherein said at least one sensor comprises optical fibers that cross the position and an optical grating disposed on said substrate, whereby light passing through said optical fibers is deflected when contact is made by said TMS coil to said position so as to change an amount of light reflected by said optical grating, the reflected light being detected by an optical detector.

24. A TMS system as in claim 23, wherein said optical detector comprises one of a photodiode and a photo transistor.

25. A TMS system as in claim 9, wherein said at least one sensor comprises an acoustic sensor that detects sound waves generated when said TMS coil is pulsed by said pulse generating device and provides a detected signal to said signal processing circuitry for a determination as to whether the detected signal is indicative of said TMS coil being pressed against the patient.

26. A TMS system as in claim 9, further comprising an acoustic device that produces a sound when said TMS coil is pulsed by said pulse generating device and reduces an amplitude of said sound as the acoustic device is compressed by the TMS coil against the position and wherein said at least one sensor comprises at least one acoustic sensor that detects said sound and

provides an amplitude signal to said signal processing circuitry for a determination as to whether an amplitude change has occurred.

27. A TMS system as in claim 9, wherein said at least one sensor comprises a conductive disk placed in a cavity bounded by flexible substrates, said conductive disk moving within the cavity when said flexible substrates are not compressed so as to cause an audible sound when said TMS coil is pulsed by said pulse generating device.

28. A TMS system as in claim 27, wherein compression of said flexible substrates against the position substantially immobilizes the conductive disk so as to reduce or eliminate said audible sound.

29. A TMS system as in claim 9, wherein said at least one sensor comprises inductive coupling sensors comprising at least one tuned coil mounted on said substrate, wherein a tuned frequency of said at least one tuned coil shifts when said TMS coil is in physical contact with the position.

30. A TMS system as in claim 29, wherein a shape of said tuned coil is distorted when compressed against the position by said TMS coil, and a resulting induced current in said tuned coil is detected by said signal processing circuitry to provide said indication of whether said TMS coil is properly disposed with respect to the position during application of pulses to said TMS coil.

31. A TMS system as in claim 9, wherein said at least one sensor comprises EEG leads that sense currents induced in the position by a TMS pulse from said TMS coil.

32. A TMS system as in claim 31, wherein said signal processing circuitry compares amplitudes of sensed currents to a threshold as said indication of whether said TMS coil is properly disposed with respect to the position during application of pulses to said TMS coil.

33. A TMS system as in claim 9, wherein said at least one sensor comprises at least one temperature sensor.

34. A TMS system as in claim 33, wherein said signal processing circuitry processes outputs of said temperature sensors to determine if a temperature difference between respective temperature sensors is above a predetermined threshold.

35. A transcranial magnetic stimulation (TMS) system for providing TMS treatment to a patient, comprising:

a TMS coil;

a pulse generating device that applied pulses to said TMS coil during TMS treatment of a patient;

a loop of conducting material placed at a position at which pulses are to be applied to said TMS coil, said loop of conducting material having an induced voltage therein when pulses are applied by said pulse generating device to said TMS coil when said TMS coil is in proximity to said loop of conducting material; and

signal processing circuitry that determines whether said induced voltage exceeds a predetermined threshold as an indication of whether said TMS coil is properly disposed with respect to the position during application of pulses to said TMS coil.

36. A device that detects the proximity of a transcranial magnetic stimulation (TMS) coil to a position of a patient during TMS treatment, comprising:

a flexible substrate disposed between said TMS coil and said position; and

at least one sensor disposed on said substrate so as to detect proximity of said TMS coil to said position.

37. A device as in claim 36, wherein said at least one sensor comprises membrane switches that change state when depressed, each membrane switch comprising respective conductive films separated by a dielectric layer.

38. A device as in claim 37, wherein said conductive films have a sufficient resistance so as to reduce eddy currents therein.

39. A device as in claim 37, further comprising non-conductive micro slides applied to said flexible substrate so as to amplify compression of said membrane switches.

40. A device as in claim 37, wherein said membrane switches comprise resistive strips that provide an output voltage that varies with position of contact on said membrane switches.

41. A device as in claim 40, wherein said membrane switches comprise an array of separators between said conductive films so as to form a touch screen.

42. A device as in claim 36, wherein said at least one sensor comprises variable resistance sensors that provide an output signal that is proportionate to applied contact pressure, whereby a change in resistance above a predetermined threshold is identified as an indication of contact.

43. A device as in claim 42, wherein said variable resistance sensors have high impedances so as to minimize induced current therein.

44. A device as in claim 36, wherein said at least one sensor comprises at least one fluid displacement sensor and fluid filled bladders connected by a non-compressible manifold to said at least one fluid displacement sensor such that compression of a bladder causes a change in pressure at the at least one fluid displacement sensor.

45. A device as in claim 44, wherein said at least one fluid displacement sensor, said fluid filled bladders and said non-compressible manifold are disposed on an electrical shielding device that shares said flexible substrate.

46. A device as in claim 44, wherein fluid filled bladders are disposed directly over respective pole faces of said TMS coil during TMS treatment.

47. A device as in claim 44, wherein fluid in said fluid filled bladders comprises a substantially non-electrically-conductive fluid.

48. A device as in claim 36, wherein said at least one sensor comprises optical fibers that cross the position and an optical grating disposed on said substrate, whereby light passing through said optical fibers is deflected when contact is made by said TMS coil to said position so as to change an amount of light reflected by said optical grating, the reflected light being detected by an optical detector.

49. A device as in claim 48, wherein said optical detector comprises one of a photodiode and a photo transistor.

50. A device as in claim 36, wherein said at least one sensor comprises an acoustic sensor that detects sound waves generated when said TMS coil is pulsed by a pulse generating device and provides a detected signal to signal processing circuitry for a determination as to whether the detected signal is indicative of said TMS coil being pressed against the patient.

51. A device as in claim 36, further comprising an acoustic device that produces a sound when said TMS coil is pulsed by a pulse generating device and reduces an amplitude of said sound as the acoustic device is compressed by the TMS coil against the position and wherein said at least one sensor comprises at least one acoustic sensor that detects said sound and provides an amplitude signal to signal processing circuitry for a determination as to whether an amplitude change has occurred.

52. A device as in claim 36, wherein said at least one sensor comprises a conductive disk placed in a cavity bounded by flexible substrates, said conductive disk moving within the cavity when said flexible substrates are not compressed so as to cause an audible sound when said TMS coil is pulsed by a pulse generating device.

53. A device as in claim 52, wherein compression of said flexible substrates against the position substantially immobilizes the conductive disk so as to reduce or eliminate said audible sound.

54. A device as in claim 36, wherein said at least one sensor comprises inductive coupling sensors comprising at least one tuned coil mounted on said substrate, wherein a tuned frequency of said at least one tuned coil shifts when said TMS coil is in physical contact with the position.

55. A device as in claim 54, wherein a shape of said tuned coil is distorted when compressed against the position by said TMS coil, and a resulting induced current in said tuned coil is output as an indication of whether said TMS coil is properly disposed with respect to the position during TMS treatment.

56. A device as in claim 36, wherein said at least one sensor comprises EEG leads that sense currents induced in the position by a TMS pulse from said TMS coil.

57. A device as in claim 36, wherein said at least one sensor comprises temperature sensors.

58. A device as in claim 36, wherein said at least one sensor comprises a loop of conducting material placed at the position under said TMS coil, said loop of conducting material having an induced voltage therein when pulses are applied to said TMS coil when said TMS coil is in proximity to said loop of conducting material.

59. A method of providing transcranial magnetic stimulation (TMS) treatment to a patient, comprising the steps of:

detecting proximity of a TMS coil to a position at which pulses are to be applied to the TMS coil during TMS treatment of a patient;

providing an indication of whether said TMS coil is properly disposed with respect to said position during application of pulses to said TMS coil.

60. A method as in claim 59, wherein said step of detecting proximity comprises the steps of disposing a sensor between said TMS coil and said position, applying pulses to said TMS coil during TMS treatment of the patient, and detecting proximity of said TMS coil to said position using said sensor.

61. A method as in claim 60, wherein said TMS coil comprises at least one treatment face and said proximity detecting step comprises the step of determining from said outputs of said sensor whether said at least one treatment face is disposed at said position.

62. A method as in claim 61, wherein said TMS coil comprises first and second treatment faces corresponding to respective pole faces of said TMS coil and said proximity detecting step comprises the step of determining from said outputs of said sensor whether said first and second treatment faces are disposed at said position.

63. A method as in claim 60, wherein said proximity detecting step comprises the step of processing said outputs of said sensor to determine if said TMS coil has a valid contact with a patient at said position.

64. A method as in claim 59, comprising the further step of providing said indication to a display device for visually indicating to an operator whether said TMS coil is properly positioned at the position.

65. A method as in claim 64, comprising the further step of presenting on said display device a visual indication of which direction to move said TMS coil to said position in the event that said TMS coil is not at said position.

66. A method as in claim 64, comprising the further step of presenting on said display device a pressure map indicating where said TMS coil has proper contact at the position and where the TMS coil does not have proper contact at the position.

67. A method as in claim 59, comprising the further step of providing said indication to a sound generator that generates a sound indicating to an operator whether said TMS coil is properly positioned at the position.

68. A method as in claim 60, wherein said step of disposing the sensor comprises the steps of placing a plurality of sensors in or on a flexible substrate and placing said flexible substrate between said TMS coil and the position to determine if said TMS coil is properly positioned with respect to said position during TMS therapy.

69. A method of providing transcranial magnetic stimulation (TMS) treatment to a patient, comprising the steps of:

disposing a loop of conducting material at a position at which pulses are to be applied to a TMS coil during TMS treatment of a patient, said loop of conducting material having an induced voltage therein when pulses are applied to said TMS coil when said TMS coil is in proximity to said loop of conducting material;

applying pulses to said TMS coil during TMS treatment of the patient;

measuring said induced voltage; and

determining whether said induced voltage exceeds a predetermined threshold as an indication of whether said TMS coil is properly disposed with respect to the position during application of pulses to said TMS coil.